

Claims

- [c1] 1. A method of resolving a plurality of vehicle torque requests comprising:
resolving torques requested at a first level to produce at least one desired first level base torque and at least one desired first level fast torque;
translating the desired first level base and fast torques through transmission effects between the first level and a second level; and
resolving the translated desired base and fast torques at the second level to produce at least one desired second level base torque and at least one desired second level fast torque.
- [c2] 2. The method of claim 1 wherein resolving at the first level comprises arbitrating between a plurality of requested torques.
- [c3] 3. The method of claim 1 wherein resolving at the second level comprises arbitrating between a plurality of requested torques.
- [c4] 4. The method of claim 1 wherein resolving at the first level comprises coordinating among a plurality of torque

producing devices based on torque availability of at least one torque producing device.

- [c5] 5. The method of claim 1 wherein resolving at the second level comprises coordinating among a plurality of torque producing devices based on torque availability of at least one torque producing device.
- [c6] 6. The method of claim 1 wherein the second level is a transmission input level.
- [c7] 7. The method of claim 1 wherein the first level is a wheel level.
- [c8] 8. The method of claim 7 wherein resolving at the wheel level comprises:
arbitrating base tractive requests to generate at least one desired wheel torque;
filtering the at least one desired wheel torque for jerk control; and
arbitrating the filtered desired wheel torque and fast requests to produce the desired first level base and fast torques.
- [c9] 9. The method of claim 7 wherein the at least one desired first level base torque and the at least one desired first level fast torque comprise a front base torque request, a front fast torque request, a rear base torque re-

quest and a rear fast torque request.

- [c10] 10. The method of claim 9 wherein the second level is a transmission input level and wherein resolving at the transmission input level comprises:
arbitrating translated front base and front fast torque requests with transmission input level requests; and
arbitrating translated rear base and rear fast torque requests with transmission input level requests.
- [c11] 11. The method of claim 10 further comprising:
coordinating front base and front fast torque requests among front axle torque devices; and
coordinating rear base and rear fast torque requests among rear axle torque devices.
- [c12] 12. The method of claim 7 wherein at least one of the at least one desired wheel level fast torque and the at least one desired wheel level base torque comprises a scalar representing the entire vehicle.
- [c13] 13. The method of claim 7 wherein at least one of the at least one desired wheel level fast torque and the at least one desired wheel level base torque comprises an array with at least one element representing an axle.
- [c14] 14. The method of claim 7 wherein at least one of the at least one desired wheel level fast torque and the at least

one desired wheel level base torque comprises an array with at least one element representing a wheel.

[c15] 15. The method of claim 1 further comprising:
determining a torque availability for at least one second level device;
translating the at least one second level device torque availability to the first level; and
resolving torque at the first level based on the translated device torque availability.

[c16] 16. The method of claim 15 wherein determining the second level device torque availability comprises:
determining a front device torque availability of a front torque producing device driving a front axle; and
determining a rear device torque availability of a rear torque producing device driving a rear axle.

[c17] 17. The method of claim 1 wherein resolving torques requested at the first level comprises generating at least one first level torque request for an electric motor generating torque at the first level to implement electric four-wheel drive.

[c18] 18. The method of claim 1 wherein resolving the translated desired base and fast torques at the second level produces at least one torque request for an integrated

starter-generator.

- [c19] 19. The method of claim 18 wherein the vehicle comprises a clutch coupling the integrated starter-generator to an engine, the clutch operative to substantially disengage the engine from the integrated starter-generator.
- [c20] 20. The method of claim 1 further comprising resolving torque on at least one additional level based on at least one torque request resolved on at least one of the first level and the second level.
- [c21] 21. A vehicle comprising:
a plurality of torque requesting elements, each torque requesting element generating at least one of slowly changing torque requests and rapidly changing torque requests;
at least one torque producing device;
at least one transmission, each transmission translating torque from at least one of the at least one torque producing device to at least one wheel; and
a control system in communication with each torque requesting element and each torque producing device, the control system operative to
(a) resolve wheel level torque requests,
(b) translate wheel level torque requests through each of the at least one transmission to at least one transmission

input level,

(c) resolve translated wheel level torque requests together with transmission input level torque requests, and

(d) generate commands for the at least one torque producing device based on the resolved torque requests.

[c22] 22. The vehicle according to claim 21 wherein the control system is further operative to resolve torque requests at the wheel level into at least one base torque request and at least one fast torque request.

[c23] 23. The vehicle according to claim 22 wherein the control system, in resolving wheel level torque requests, is further operative to
arbitrate the at least one base torque request to generate at least one arbitrated base torque request;
filter the at least one arbitrated base torque request to produce a filtered base torque request; and
arbitrate the filtered base torque request and the at least one fast torque request.

[c24] 24. The vehicle according to claim 21 wherein the control system resolves torque requests on at least one of the transmission input level and the wheel level by arbitrating between a plurality of torque requests.

[c25] 25. The vehicle according to claim 24 wherein the con-

trol system resolves torque requests on at least one level by coordinating among a plurality of torque producing devices based on torque availability of each torque producing device.

[c26] 26. The vehicle according to claim 21 wherein the resolved wheel level torque requests comprise a front base torque request, a front fast torque request, a rear base torque request and a rear fast torque request.

[c27] 27. The vehicle according to claim 26 wherein the control system is further operative to:
arbitrate translated front base and front fast torque requests with transmission input level requests; and
arbitrate translated rear base and rear fast torque requests with transmission input level requests.

[c28] 28. The vehicle according to claim 27 wherein the control system is further operative to:
coordinate front base and front fast torque requests among front axle torque producing devices; and
coordinate rear base and rear fast torque requests among rear axle torque producing devices.

[c29] 29. The vehicle according to claim 21 wherein the control system is further operative to:
resolve at least one transmission input torque producing

device availability;
translate the at least one transmission input torque producing device availability through the transmission to the wheel level; and
coordinate torque requests at the wheel level based on the translated availability.

[c30] 30. The vehicle according to claim 21 wherein the control system is further operative to:
determine a front torque producing device availability;
and
determine a rear torque producing device availability.

[c31] 31. The vehicle according to claim 21 wherein at least one arbitrated torque request comprises a scalar representing the entire vehicle.

[c32] 32. The vehicle according to claim 21 wherein at least one arbitrated torque request comprises an array with at least one element representing an axle.

[c33] 33. The vehicle according to claim 21 wherein at least one arbitrated torque request comprises an array with at least one element representing a wheel.

[c34] 34. A controller for resolving torque comprising:
a wheel level resolver generating at least one of wheel level base requests and wheel level fast requests based

on wheel level traction requests;
a translator generating translated base requests and translated fast requests corresponding to the at least one wheel level base requests and the wheel level fast requests based on a state of at least one transmission;
and
a transmission input level resolver generating transmission input level base requests and transmission input level fast requests based on the translated base requests, the translated fast requests and transmission input level requests.

- [c35] 35. The controller according to claim 34 wherein the wheel level traction requests comprise at least one of accelerator pedal position, vehicle speed and desired vehicle speed.
- [c36] 36. The controller according to claim 34 further comprising driveline disturbance control filtering wheel level base requests based on actual tractive force.
- [c37] 37. The controller according to claim 36 wherein the actual tractive force is based on the state of the at least one transmission.
- [c38] 38. The controller according to claim 34 wherein the wheel level resolver further generates at least one signal

indicative of tractive force source.

[c39] 39. The controller according to claim 38 wherein the transmission input level resolver generates at least one of the transmission input level base requests and the transmission input level fast requests based on the signal indicative of tractive force source.

[c40] 40. The controller according to claim 34 wherein the transmission input level base requests and transmission input level fast requests comprise desired engine torque base, desired engine torque fast, and desired integrated starter-generator torque.

[c41] 41. The controller according to claim 34 wherein the wheel resolver generates torque requests for controlling at least one wheel level torque producing device.

[c42] 42. The controller according to claim 41 wherein the at least one wheel level torque producing device implements four-wheel drive.

[c43] 43. The controller according to claim 41 wherein the at least one wheel level torque producing device implements vehicle deceleration.